Augmented reality learning
education in real-world contexts

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Potential impact	high
Timescale	long term
Keywords	augmented reality, real-world contexts, immersive technology, embodied learning, situated learning

What is it?

Augmented Reality (AR) bridges the real and the digital. It is part of the Extended Reality (XR) spectrum of immersive technological interfaces. At one end of the continuum, Virtual Reality (VR) immerses users in fully digital simulations which effectively substitute for the real world. At the other end of the continuum, AR allows users to remain immersed in the real world while superimposing digital overlays on the world. The term *mixed reality*, meanwhile, is sometimes used as an alternative to AR and sometimes as an alternative to XR.

In a broad conceptual view, AR refers to the dynamic presentation, in a real-world setting, of digital information and communication channels which are contextually relevant (with certain non-contextualised exceptions such as some app-based 3D models); in a narrower technocentric view, AR refers to the "direct superimposition of digital information and communication channels on our perceptions of a real-world setting" (Pegrum, 2019, p. 57). While XR headsets allow for truly immersive experiences, AR is currently most commonly seen on smartphones (or tablets) where AR browsers or apps overlay digital text, images, videos, and/or 3D objects, which may or may not

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be interactive, on a user's view of the real-world environment as registered through the phone's camera and displayed on its screen (see Figure 1). AR overlays may be triggered by visual markers (at the simplest, QR codes), AI-powered object recognition, and/or location (generally using GPS or Bluetooth). As AR is advancing, the conceptual and technocentric definitions are in the process of merging, with the direct superimposition of digital data on our perceptions becoming the norm.

Figure 1. Times Square, New York City, seen through the Wikitude AR browser. Source: Wikitude, under CC BY-SA 2.0 licence, from www.flickr.com/photos/wikitude/30944213892/

Pedagogically, AR invites three main uses (MacCallum & Parsons, 2019). It can be used for *information transmission* activities where students access learning materials, authored by their teachers or external experts, in context; for *(social) constructivist* activities where students individually or collaboratively record, annotate, interact with, and/or modify elements of their virtual or real settings; and for *constructionist* activities where students employ today's user-friendly tools to design and build AR artefacts or experiences, potentially even making this user-generated content available to support others' learning.

Examples

Inside the classroom, language teachers have enhanced learning materials through the use of AR tools like *ARientation*, *Augment,* and *Aurasma/HP Reveal* (the last of these now discontinued). These enable students to scan textbooks, handouts, or cards with a smartphone to reveal images, videos, polls, or discussion boards. But the possibilities are far greater outside the classroom, where language teachers have used AR tools like *ARIS* (Field Day), *FreshAiR* (MoGo Mobile), *Pocket Trips* (LDR), and *Trail Shuttle* (Rockmoon) to build learning trails which are akin to gamified scavenger hunts. Accessed by students on phones or tablets, they typically consist of a series of real-world stations where students receive a digital question to answer or problem to solve and, in so doing, are led to the next station on the trail.

Figure 2. Girls interacting with an AR overlay on an LDR LocoMole trail in Chinatown, Singapore; reproduced with kind permissions from © LDR

In the *Explorez!* mobile game in Canada (2014-present, built with ARIS), the English-speaking campus of the University of Victoria, British Columbia, is overlaid with a virtual French campus. Students act as personal assistants to an imagined Francophone celebrity visitor, practising their spoken French as they carry out tasks in various campus locations and make recommendations to

enhance the celebrity's visit. In the *Surviving Alaska* mobile game in the USA (2014-present, also built with ARIS), primary school children who have been learning bilingually in English and Yup'ik (an Alaskan Native language) play the role of survivors of an apocalypse. After watching elders explain traditional knowledge in Yup'ik-language videos geotagged to relevant locations around the local village, they seek additional information through interviews with other elders and then demonstrate their learning by, for example, building a shelter or finding medicinal plants. In the *Fukuchiyama Castle Rally* in Japan (2017, built with Blippar), new undergraduate students from the University of Fukuchiyama worked in teams to locate AR cards containing contextually relevant English vocabulary, collecting secret codes along the way which allowed them to open a locked box at the end of their mission. On the *Torrens Walkabout Trail* in Australia (2018-present, built with My Tours), students taking English classes at the University of South Australia get to know Adelaide with the support of situated multimedia materials, record their own multimodal responses to their environment, practise relevant language, and ultimately develop their descriptive writing.

On the *Interactive Heritage Trails* in Singapore (2008-present, built with Pocket Trips), which have a social studies focus but incorporate elements of language and literacy, school students explore their city station by station. In a three-step process, students' handheld devices present multimedia materials to deepen their contextual understandings, pose factual questions they can answer using locally available information, and finally invite their collaborative, multimodal responses to their real-world learning environment, typically in the form of videos to be shared later with their teacher and classmates (for an example of a newer trail by the same company, see Figure 2). Meanwhile, students have successfully worked with authoring software such as Pocket Trips and Trail Shuttle to construct stations on learning trails, or indeed entire learning trails, for their peers, honing their own language skills in the process.

Benefits

Because AR, unlike VR, works with, rather than against, our embodiment and embeddedness in everyday real-world contexts, it supports learning that is

embodied and active; situated, contextualised, and place-based; and authentic and often informal. Furthermore, because it bridges the real and the digital, and facilitates a continuation of learning outside the usual places and times of education, AR supports seamless learning across contexts (even if specific learning experiences may be contextualised). Using, and especially developing, AR content fosters a range of digital literacies, including multimodal, spatial, information, and coding literacy.

The emerging empirical research literature has found AR to be motivating for students, especially when fused with gaming elements. It seems increasingly clear that AR offers benefits for certain content – for example, concrete descriptive language (Pegrum, 2019) – and certain learners, but more research is needed to definitively establish exactly when and where it is of greatest value for language learning.

Potential issues

Current technological issues include the limited screen size and field of view on phones (Sailer, Rudi, Kurzhals, & Raubal, 2019), the cost of immersive headsets (though this is falling), the data demands (though 5G will help), and the lack of interoperability of software (though this will likely come with time). Educational issues, beyond the accessibility of hardware, software, and internet connectivity, include the need to move past using AR for its own sake and to identify its specific benefits. Issues with cognitive overload and distraction, and with privacy and surveillance, may be addressed in part through the development of attentional literacy and personal/security literacy, respectively.

Looking to the future

As we move from smartphones to headsets, smart glasses, and even smart contact lenses, and as input mechanisms come to routinely include voice, gesture, and eye tracking, AR will offer an ever more immersive and seemingly natural experience. Importantly, as

our technology increasingly facilitates the transmission of spatial audio and haptics, and very likely eventually smell and taste, AR will also offer a more multisensory experience. In education, this will mean access to more varied learning materials, more modes of collaboration, and more possibilities for self-expression.

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